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OBSERVATIONS ON THE JAPANESE SALAMANDER, CRYPTOBRANCHUS MAXIMUS (Schlegel).

—BY—

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OBSERVATIONS ON THE JAPANESE SALAMANDER, CRYPTOBRANCHUS MAXIMUS (Schlegel).

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Questions as to what constitute a good or a bad species, whether a species should be elevated to the rank of a genus, or degraded to that of a variety, concerning which naturalists at one time disputed so vehemently, have lost much of their interest in the light of evolution. Indeed, if all the extinct forms of animal life could be reproduced, the gaps now separating living ones would be so bridged over that the species, orders, families, etc., of the systematic zoologist would cease to have any significance whatever.

As an illustration of such conflict of opinion may be cited the difficulty experienced by naturalists in assigning to the great Japanese salamander its proper position in relation to other batrachia, it having been named successively *Salamandra maxima*,[1] *Megalobatrachus sieboldii*,[2] *Sieboldia maxima*,[3] *Cryptobranchus japonicus*,[4] *Megalobatrachus maximus*,[5] and, finally, if the author's interpretation of its organization be accepted, *Cryptobranchus maximus*. Inasmuch as the Japanese salamander is not a salamander, as was supposed by Schlegel, the name *Salamandra* was soon set aside, as it gave an erroneous idea as to the affinities of the animal. Tschudi, regarding the form as sufficiently peculiar in its organization to warrant placing it in a distinct genus, designated it as *Megalobatrachus sieboldii*. Bonaparte, afterwards, wishing to do honor to the distinguished naturalist Siebold, who first introduced the Japanese animal to the notice of Europe, and regarding it also as a distinct genus of batrachia, named it *Sieboldia*. The name *Cryptobranchus* was given as long ago as 1821 by Leuckart[6] to our common Allegheny hell-bender. That animal having been described, however, a few years later by Harlan,[7] first as *Abranchus*, a name soon given up, it having been previously given by Hasselt to a mollusk from Java,

[1] Schlegel, Fauna Japonica, Lugd. Bat. 1838, p. 127, pls. 6–8.
[2] Tschudi, Batrachia, Neuchatel, 1838, p. 96, Taf. viii.
[3] Bonaparte, Fauna Italica, Tomo II, Roma 1832–1841. Sheet 131 * * * see Euproctus.
[4] Van der Hoeven, Proc. Zoo. Soc., London, 1838, p. 25.
[5] Boulenger, Catalogue of the Batrachia Gradientia, London, 1882, p. 80. Cope, The Batrachia of North America, Washington, 1889, p. 37.
[6] Isis von Oken, Jena, 1821, p. 259.
[7] Annals of the Lyceum of Nat. History, New York, 1824, pp. 222, 270.

then as *Menopoma alleghaniensis*, naturalists, at least in this country, in speaking of the hell-bender usually refer to it even now as the *Menopoma*, of course improperly, as the name *Cryptobranchus*, having priority, should be used in preference. Van der Hoeven[8] regarding the so-called Japanese salamander as essentially in its organization nothing but a big hell-bender or *Menopoma*, named it *Cryptobranchus japonicus*, the *Menopoma* of Harlan being then consistently designated as *Cryptobranchus alleghaniensis*, and the name *Menopoma* was set aside.

Boulenger and Cope, high authorities on the subject of the batrachia, regarding, however, as Tschudi and Bonaparte did, the Japanese animal as differing sufficiently from the American hell-bender (*Cryptrobranchus* syn. *Menopoma*) to warrant placing it in a distinct genus, have revived in recent times the old name and designate it now *Megalobatrachus maximus*.

In dissecting recently a fine specimen of the Japanese animal, measuring 46 inches in length (115 cent.) which lived for a number of years in the Philadelphia Zoological Garden, the author was much impressed with the similarity of its organization to that of our common hell-bender, of which he has dissected numerous specimens. It may not be superfluous therefore to call attention to such parts of the anatomy of the Japanese batrachian as have not been already described, to those points in which the organization of the Japanese and American forms agree and disagree, finally, as to why, in the judgment of the author, the Japanese batrachian should be regarded as a big hell-bender, a kind of *Cryptobranchus* or *Menopoma*, rather than as a distinct genus *Megalobatrachus*.

The myology, splanchnology and nervous system of the Japanese animal have been described by Goddard, Schmidt and Van der Hoeven.[9] Peculiarities of the hyoid apparatus and of the muscular and nervous systems are incidentally alluded to by Fischer,[10] more particularly in their relation to the corresponding parts in the Perennibranchiata and Derotremata. The osteology and splanchnology are well considered by Hyrtl[11] in his beautifully illustrated mono-

[8] Tijdschrift voor Natuurlijke Geschiedenis, 1837–1838, p. 375.

[9] Aanteekenigen over de anatomie van den Cryptobranchus Japonicus, Haarlem, 1862.

[10] Anatomische Abhandl. über die Perennibranchiaten und Derotremen, Hamburg, 1864.

[11] Cryptobranchus Japonicus, Vindobonae, 1865.

graph, while the blood corpuscles have been studied by Van der Hoeven,[12] Harting,[13] Crisp[14] and Gulliver.[15]

The Japanese batrachian having attracted the attention of so many eminent anatomists, as might naturally be supposed there remains but little to be said that is new concerning its organization. The author would, however, call attention to the fact that while Hyrtl's description of the disposition of the pulmonary and branchial arteries is such as observed by himself, nevertheless his figure (op. cit. Plate II, fig. 4) illustrating the same is apt to mislead, as it gives the impression that the two branchial arteries that unite to form the aorta lie above the heart, whereas their natural position is such as is represented in Plate V, fig. I; 2, 3. Again, in reference to the course of the pulmonary vein that conveys arterialized blood from the lungs to the left auricular part of the heart especially disposed to receive it, Hyrtl (op. cit. p. 94) simply says: "Foramen venae pulmonalis in atrio sinistro, nullam valvulam praetextam habet, ambitus ejus calami tenuioris introductionem concedit."

In order to remove any obscurity that may prevail on this point, the author takes occasion to observe that the common pulmonary vein (indicated by the bristle, Plate V, fig. 2, a), formed by the union of the two pulmonary veins passes along the inner side of the common sinus, fig. 2, S, receiving the blood from the two pre-caval and post-caval veins, without, however, communicating with it, and enters the left auricular part of the heart, L A, by a distinct opening, the sinus S just referred to entering the right auricular part, R A, of the heart by an equally distinct one.[16] It is needless to add that the author found the delicate septum separating the auricles incomplete.

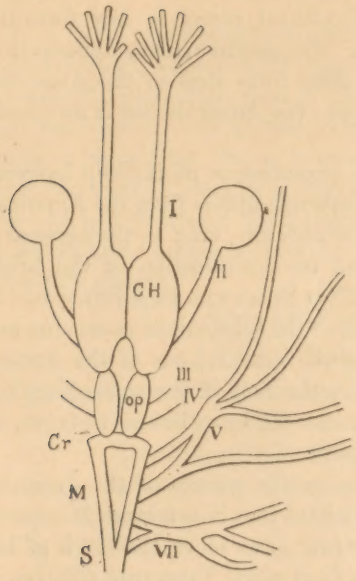
The blood corpuscles having been previously described by a number of observers, it would be superfluous to dwell further upon their

[12] Tijdschrift voor Natuurlijka Geschiedenis, etc., 8, 1841, p. 270.
[13] Verslagen, Amsterdam, 1858, p. 368.
[14] Proc. Zoological Society, London, 1860, p. 204.
[15] Proc. Zoological Society, London, 1873, p. 162.
[16] At the time that the above was written, the author had not seen the Aantekenigen of Van der Hoeven. Through the courtesy of the Smithsonian Institution a copy of that work having been kindly placed at his disposal, he learned that his description of the pulmonary vein was essentially the same as that previously given by the Dutch anatomists—p. 43: "De daardoor ontstane vena pulmonalis communis is nog 57 mms. lang. en geheel vergroeid met de vena cava, met welke zig opklint, zich lang zamer hand naar de regter zij de slingerende; de in monding in den linker voorhof is aan deszelfs achterwand gelegen, en iets meer naar boven dan de opening der vena cava in den regter voorhof, der halve geenszins in de onmiddellijke nabijheid van de spleet vormige opening onder aan het septum atriorum."

characters. In this connection it should be stated, however, as the previous measurements made differ very considerably, that those of the author, viz. $\frac{1}{15}$ mm. in the longest and $\frac{1}{32}$ mm. in the shortest diameter, agree most closely with those of Gulliver. The disposition of the genito-urinary apparatus is essentially the same as that which generally obtains in the male derotrematous batrachia. The form, position and relation of the testicles, their ducts passing into the upper part of the Wolffian bodies, the ducts from the latter passing in turn into the common genito-urinary duct, the openings of the latter and that of the bladder into the cloaca, are so well shown by the representations from nature, Plates VI, VII, and the accompanying diagrammatic figure, Plate VII, fig. 2, that any particular detailed description of the same is unnecessary.

Whatever may be the views of zoologists as to the natural affinities of the Japanese batrachian, there has never been any difference of opinion among anatomists on this point; at least all those who have had the opportunity of dissecting the animal have regarded it as a large *Cryptobranchus* or *Menopoma*, the two animals resembling each other so closely in their organization. Thus, for example, the skull of the American *Menopoma* is a miniature of that of the Japanese form. The hyoid apparatus in both animals consists of the basi-hyal, glosso-hyal and cerato-hyal constituents. The glosso-hyal is, however, sometimes subdivided into two pieces in *Cryptobranchus*, while the cerato-hyals in the Japanese animal differ from the homologous parts in the American one in being usually[17] unsegmented, gristly and joined to the glosso-hyal. While it is true that in the branchial arches of the Japanese form only the first and second pair persist, the remaining two pairs, corresponding to the third and fourth pairs of the American form, disappearing, it will be observed that those pairs which persist in the former agree with the corresponding ones in the latter in that the first pair is unsegmented and that the second pair is segmented and ossified. It should be mentioned in this connection that the first pair of arches in the Japanese animal unite at their inner ends, whereas the corresponding pair in the American animal remain ununited. The uro-hyal bone is, however, absent in both animals.

[17] Stannius, Handbuck der Zootomie, zweiter Theil, Berlin, 1856, S. 64—"Auch Salamandra maxima besitz drei Bogen: einen vordersten knorpeligen, dessen Seitenschenkel je aus zwei Stücken bestehen."



Brain of *Cryptobranchus maximus*.

C H, cerebral hemispheres; op, optic lobes; Cr, cerebellum; M, medulla; S, spinal cord; I, II, III, IV, V, VII, cranial nerves.

Except in the points of disagreement just mentioned, conditioned through the absence of the gill opening, it will be observed that the hyoid apparatus of the Japanese batrachian agrees essentially with that of the American one. The general character of the brain and the manner in which the cranial nerves arise and are distributed, are essentially the same in both batrachians.

As might be expected on account of the similarity in the skeleton of the two animals the disposition of the muscles is essentially the same. Indeed, as regards the cranial muscles, the only noticeable difference is the absence in the Japanese batrachian of the constrictores and adductores arcuum and the modification of the levatores arcuum conditioned by the absence of the gill opening. The remaining important muscles of the skull and hyoid apparatus, such as the temporal, masseter, digastric, sub-mentalis, sterno-hyoid, genio-hyoid and cerato-hyoid, are distributed in much the same manner in both animals.

The alimentary canal with its appendages, does not differ in the Japanese batrachian in any respect from that of the American form except that in the former animal, just within the lower jaw, two larger racemose glands, about two inches long, were found, the ducts of which opened on the floor of the mouth. From their position and structure it is to be inferred that these glands are salivary in function. Up to the present time, however, neither submaxillary nor any other kind of distinct salivary glands have been observed in the amphibia. The only notable difference in the disposition of the vascular system in the Japanese animal as compared with the American is that in the former there are three branchial vessels, 1, 2, 3, Plate V, fig. 1, while in the latter there are four.

The manner, however, in which the blood passes to and from the lungs is the same in both animals. The genito-urinary apparatus of the Japanese *Menopoma* does not differ from that of the American animal. As in the case of the skull, the latter is but a miniature of the former.

From the above resumé of the organization of the two batrachians, it will be observed that the Japanese differs from the American animal in one essential respect, and only one, viz.: in the absence of the spiraculum or gill opening, and the modification of the hyoid apparatus conditioned thereby. That little or no importance can be attached to the presence or absence of the spiraculum as serving as a generic character or as warranting the establishing of the distinct genus *Megalobatrachus*, is shown by the fact of the spiraculum not being always present in *Menopoma*. At least, in one instance, its absence was observed by Boulenger.[18]

If the views here advanced as to the nature of the Japanese batrachian be accepted, if it be admitted that it is a large *Menopoma* —a *Cryptobranchus*—it will illustrate once more the truth of the Linnæan maxim: "una nota non facit genus," the true affinities of an animal being determined, not by the presence or absence of a particular structure, but by the character of its entire organization. The position occupied by the Japanese *Cryptobranchus* or *Menopoma* among the Urodela, if the animal be admitted to be such, would then be between the Derotremata and Myctodera, according to the old classification of Stannius,[19] bridging over the gap between these groups to such an extent that their taxonomic value loses most of its significance.

- Urodela
  - Perennibranchiata
    - Siredon
    - Siren
    - Proteus
    - Menobranchus
  - Abranchiata
    - Derotremata
      - Amphiuma
      - Cryptobranchus alleghaniensis
      - Cryptobranchus maximus
    - Myctodera
      - Triton
      - Salamandra

In conclusion it may not be uninteresting to call attention to the fact that the Japanese *Cryptobranchus* was not always restricted to Japan and China as it appears to be at present, it having, at one

[18] Op. cit. p. 82.
[19] Stannius, Op. cit. S. 4.

time, a much wider geographical range, a very similar species, the so-called *Andrias scheuchzeri*, living in Miocene times in Europe. This celebrated fossil, discovered in the Œnigen quarries of Switzerland and described in 1726 by the Swiss physician, Scheuchzer,[20] is so evidently a batrachian that it is astonishing that it should ever have been regarded, at least by a physician, as the remains of a man—of one who had witnessed the deluge, "Homo Diluvii testis," and that it should have been reserved for Cuvier[21] to have correctly interpreted its nature.

Explanation of Plates.

Plate V.

Fig. 1.—Bulbus arteriosus and branchial arteries.
ba, bulbus arteriosus.
1, 2, 3, branchial arteries.
4, pulmonary artery.
a, aorta.

Fig. 2.—Heart.
S, sinus.
bristle a indicates course of pulmonary vein.
bristle b indicates course of sinus.
L A left auricle.
R A, right auricle.
V, ventricle.

Plate VI.

Fig. 1.—Urogenital apparatus, anterior view.
vd, vas deferens.
T, testicle.
dd′, ducts.
W, Wolffian bodies.
R, rectum.
B, bladder.
cl, cloaca.

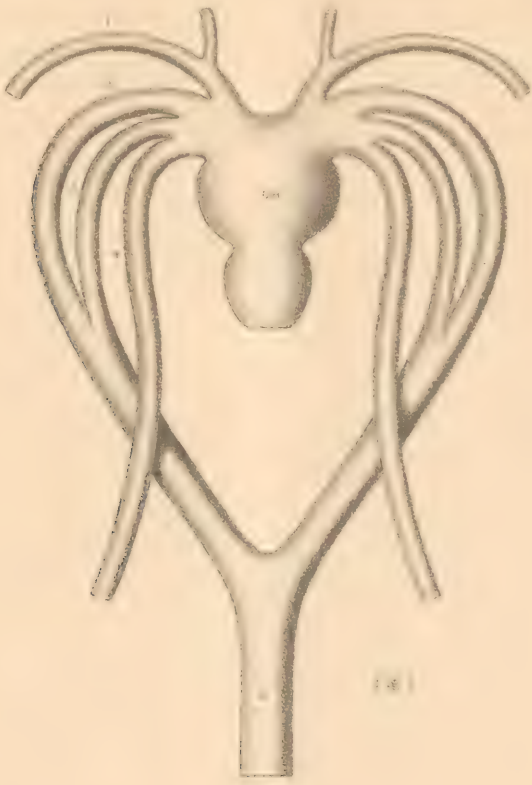
Plate VII.

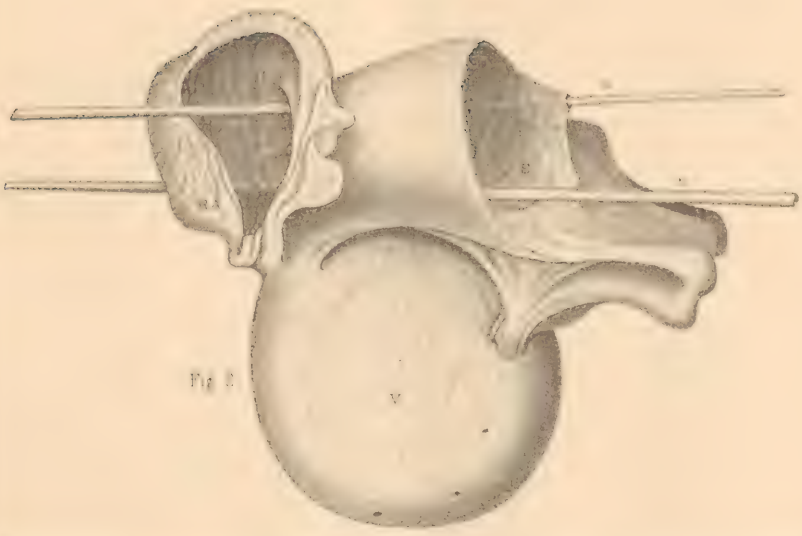
Fig. 1.—Urogenital apparatus, posterior view letters as in Plate VI.

Fig. 2.—Urogenital apparatus (diagrammatic), dd′ ducts. Remaining letters as in Plate VI.

[20] Philosophical Transactions, 1726, Vol. 34, p. 38. Homo Diluvii testis et theoskopos, Tiguri, 1726.

[21] Ossemens Fossiles, Paris, 1836, Tome Dixième, p. 360.





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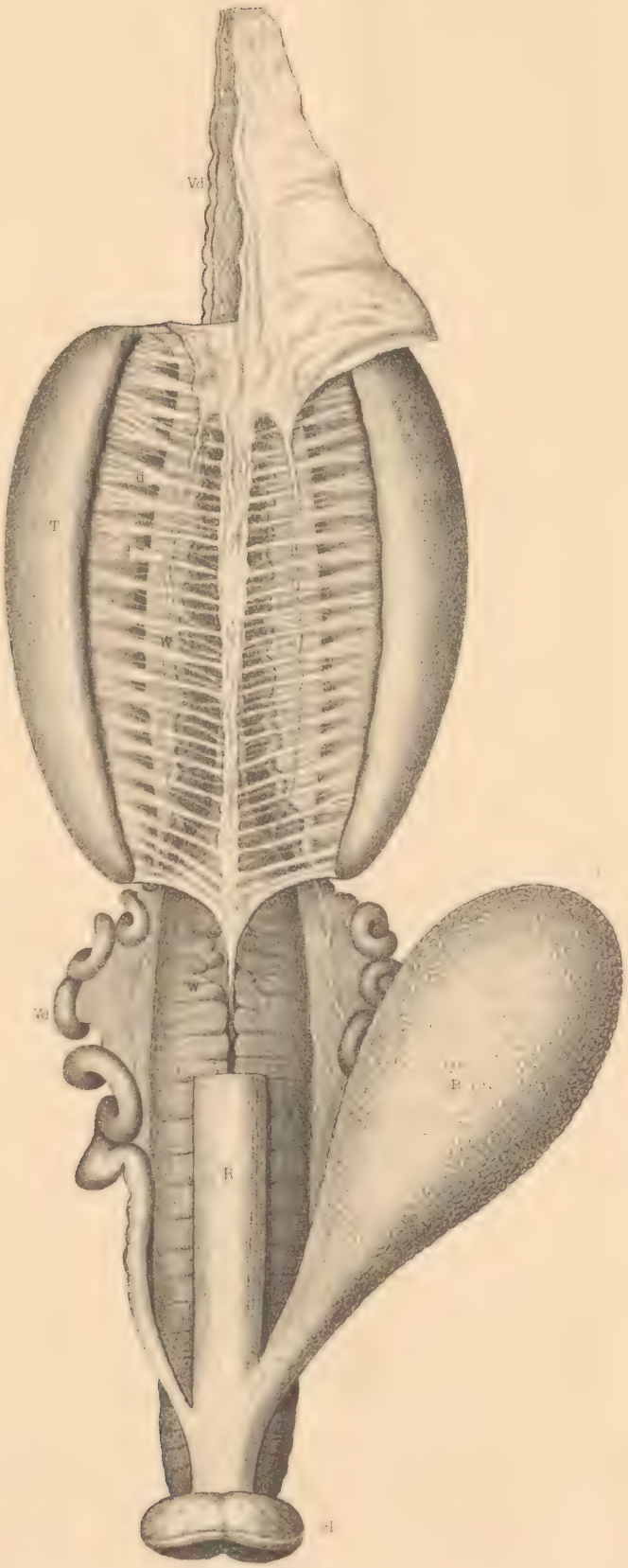

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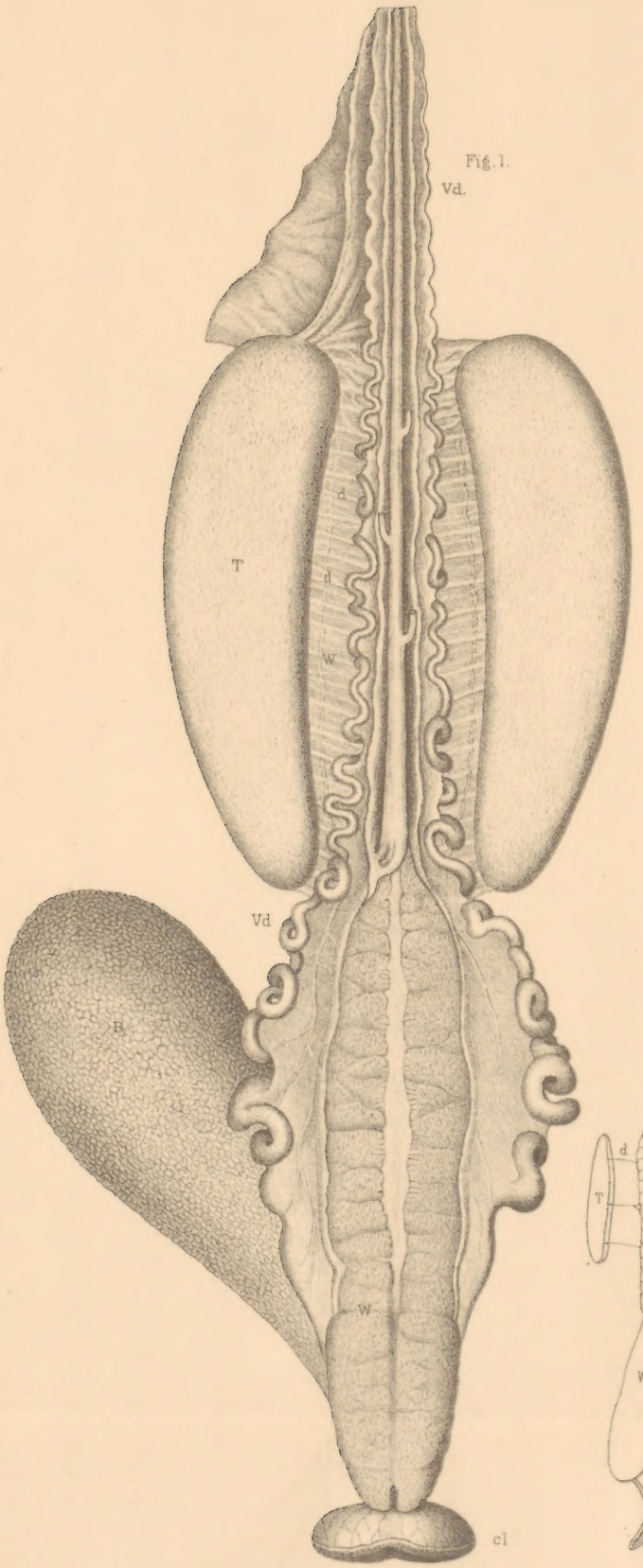

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